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IS 6553 (1971): Environmental requirements for semiconductor devices and integrated circuits [LITD 5: Semiconductor and Other Electronic Components and Devices]



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“Knowledge is such a treasure which cannot be stolen”

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IS : 6553 - 1971

Indian Standard

ENVIRONMENTAL REQUIREMENTS FOR
SEMICONDUCTOR DEVICES AND
INTEGRATED CIRCUITS

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Indian Standard

ENVIRONMENTAL REQUIREMENTS FOR SEMICONDUCTOR DEVICES AND INTEGRATED CIRCUITS

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(Continued on page 2)

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(Continued from page 1)

**Panel for Environmental Tests for Semiconductor Devices,
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Indian Standard

ENVIRONMENTAL REQUIREMENTS FOR SEMICONDUCTOR DEVICES AND INTEGRATED CIRCUITS

0. F O R E W O R D

0.1 This Indian Standard was adopted by the Indian Standards Institution on 15 November 1971, after the draft finalized by the Semiconductor Devices and Integrated Circuits Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard deals with the environmental (climatic and mechanical) requirements applicable to semiconductor devices including integrated circuits. This standard shall be used in conjunction with IS : 589-1961*.

0.3 The relevant individual specification shall specify the following:

- a) The specific test to be carried out and the appropriate severities, to be chosen from those covered in this standard;
- b) The allowed performance limits, during or after the environmental tests or both; and
- c) Any deviation to those specified with regard to test procedure, end-point measurements, etc.

0.3.1 If there is any conflict between this standard and any individual specifications, the provisions of the latter shall apply.

0.4 While preparing this standard, assistance has been derived from the following:

IEC Doc : 47 (Secretariat) 445 Essential ratings and characteristics — General requirements. International Electrotechnical Commission.

BS 9300 : 1959 Semiconductor devices of assessed quality. British Standards Institution.

JSS 51300 (Part II) Test methods for semiconductor devices. Ministry of Defence, Government of India.

1. SCOPE

1.1 This standard lays down the environmental requirements (climatic and mechanical) and the tests designed to assess the durability under

*Basic climatic and mechanical durability tests for electronic components (*revised*).

various conditions of production, use, transport and storage of semiconductor devices including integrated circuits used in electronic equipment and other similar equipment.

2. TERMINOLOGY

2.1 For the purpose of this standard, the terms and definitions given in 2 of IS : 589-1961* shall apply.

3. GENERAL CONDITIONS

3.1 Standard Atmospheric Conditions

3.1.1 Testing — Unless otherwise specified, all tests shall be carried out under standard atmospheric conditions for testing as specified in 4.3 of IS : 589-1961*, namely:

Temperature	15 to 35° C
Relative humidity	45 to 75 percent
Air pressure	860 to 1 060 mbar

3.1.2 Electrical Parameter Measurements — Unless otherwise specified, electrical parameter measurements shall be made at an ambient temperature of $25 \pm 2^\circ \text{C}$ and at the atmospheric pressure and relative humidity specified in 3.1.1. Whenever these conditions are to be closely controlled, in order to obtain reproducible results, the conditions shall be as follows:

Temperature	$25 \pm 1^\circ \text{C}$
Relative humidity	50 ± 2 percent
Atmospheric pressure	860 to 1 060 mbar

3.1.2.1 Before the electrical measurements are made, the samples shall be stored under the conditions specified in 3.1.2 for at least one hour, unless otherwise specified.

3.1.3 The ambient temperature during tests and electrical measurements shall be stated in the test report.

3.2 Equilibrium Conditions — Unless otherwise specified, all electrical measurements shall be conducted under equilibrium conditions. When these conditions cause significant variation, with time, of the characteristic being measured, means of compensation for such effects will be specified in the individual standard, for example, the length of time that the device shall be maintained at the equilibrium conditions before marking a measurement.

*Basic climatic and mechanical durability tests for electronic components (revised).

3.3 Permissible Temperature Variation in Environmental Chambers — When chambers are used, specimens under test shall be located only within the working area defined as follows:

- a) *Temperature Variation Within Working Area* — The controls for the chamber shall be capable of maintaining the temperature of the reference point within the working area within $\pm 2^\circ \text{C}$.
- b) *Space Variation Within Working Area* — Chambers shall be so constructed that, at any given time, the temperature of any point within the working area shall not deviate more than $\pm 3^\circ \text{C}$ from the reference point, except for the immediate vicinity of specimens generating heat.

3.4 Recovery Conditions and End-Point Measurements — Post test end-point measurements, specified in individual specifications, shall be carried out for each device after completion of the specified tests. All applicable end-point measurements shall be carried out within 96 hours after the samples have been subjected to the required physical, mechanical or climatic tests.

3.5 Electrical Measurements Before, During or After Conditioning — The parameters to be checked before, during and after the environmental tests shall be specified in the individual specification.

3.5.1 The parameter measurements which are generally carried out are as follows:

a) *Diodes*

- 1) Diodes for general, pulse or high voltage applications I_R and V_F
- 2) Reference diodes (forward direction) I_R , V_F and r_F
- 3) Reference and regulator diodes (reverse direction) I_R , V_Z and r_Z

b) *Transistors*: All types

I_{CBO} and h_{FE} or h_{fe}
or $V_{CE(sat)}$

c) *Thyristors*: All types

I_R , I_D , V_T and V_{GT}

d) *Integrated circuits*

Details of parameter measurement should be given in the relevant specification

4. GENERAL PRECAUTIONS

4.1 For general precautions, reference may be made to 7 to 13 of IS : 5469-1969*. In addition, the provision of 4.2 to 4.6 shall also apply.

*Code of practice for the use of semiconductor junction devices.

4.2 Overheating of the devices shall be avoided while soldering the terminals of the specimen.

4.3 The specimen shall not be subjected to transients which cause the rating to be exceeded. It is recommended that the devices should not be inserted into or removed from circuit while it is energized.

4.4 In working with specially sensitive devices, it is advisable to make the earth connection of the soldering iron to the earthed framework being assembled, to avoid the risk of possible inter 'earth' transient voltage appearing between iron and the equipment.

4.5 Due precautions should be taken while testing the devices in strong fields of electric, magnetic, electromagnetic and nuclear radiations.

4.6 During measurements, the specimens shall not be exposed to draughts, illumination or other influences likely to cause error.

5. ORIENTATIONS

5.1 Wherever applicable, the device orientation axes shall be specified to enable application of the tests appropriately.

5.1.1 Reference to Fig. 1A may be made for orientation of non-cylindrical devices to the direction of accelerating force.

5.1.2 Reference to Fig. 1B may be made for orientation of cylindrical devices to the direction of accelerating force.

5.1.3 For case configurations, other than those shown in Fig. 1A and 1B, the orientation of the device shall be as specified in the relevant individual specification.

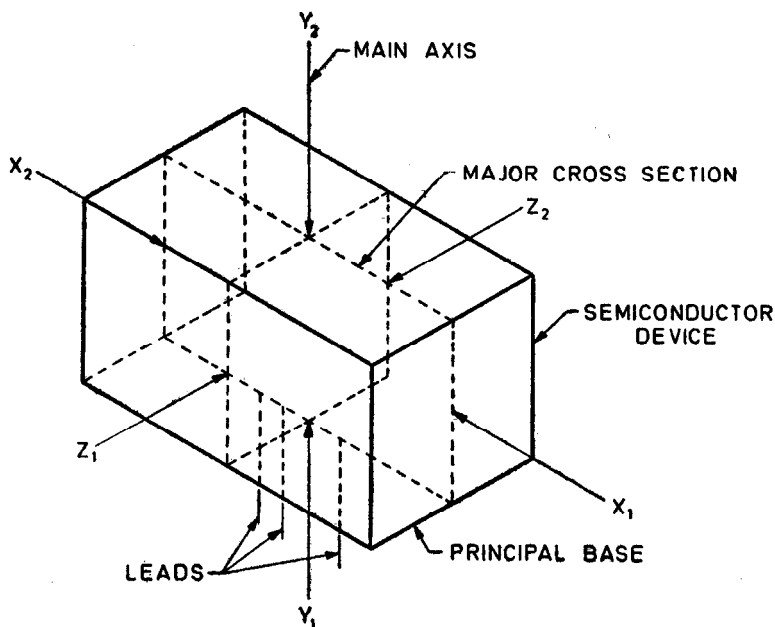
5.2 In these two Fig. 1A and 1B:

- a) X is the orientation of a device with the main axis of the device normal to the direction of accelerating force, and the major cross section parallel to the direction of accelerating force;
- b) Y is the orientation of a device with the main axis of the device parallel to the direction of the accelerating force and the principal base toward (Y_1), or away from (Y_2), the point of application of the accelerating force; and
- c) Z is the orientation of a device with the main axis and the major cross section of the device normal to the direction of the accelerating force.

6. ENVIRONMENTAL REQUIREMENTS

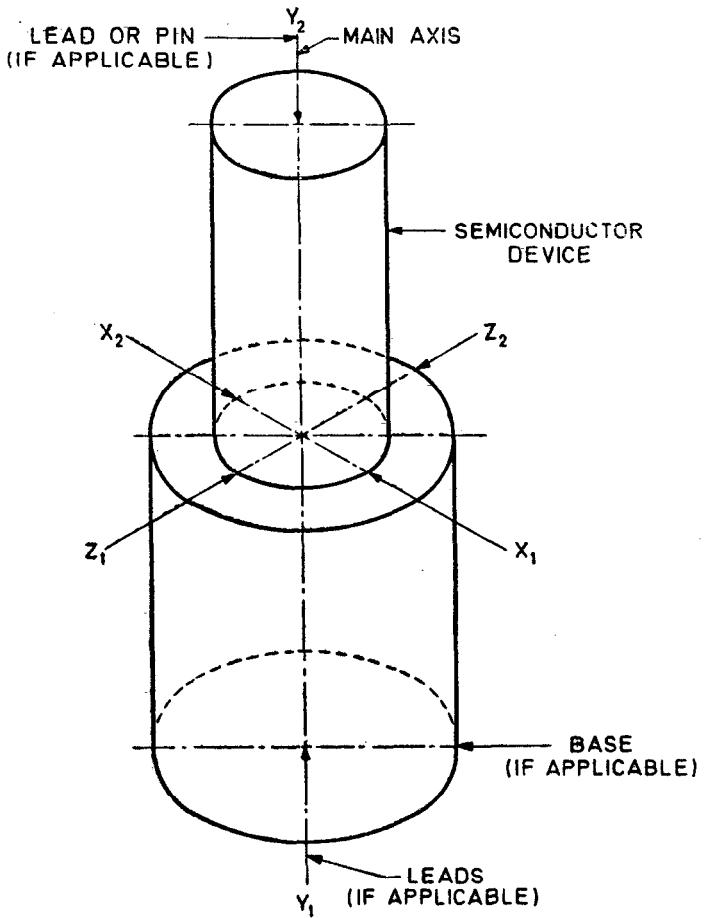
6.0 Classification of Tests — Under consideration,

6.1 Environmental Test Requirements — The details of the environmental test requirements for semiconductor devices and integrated circuits are given in Table 1 with appropriate reference to IS : 589-1961*. The choice of the appropriate tests depends on the type of devices and details of applicable tests shall be specified in the relevant individual specification (*see also 0.3*).



1A Noncylindrical Devices

*Basic climatic and mechanical durability tests for electronic components (*revised*).



1B Cylindrical Devices

FIG. 1 ORIENTATION OF DEVICES TO THE DIRECTION OF ACCELERATING FORCE

TABLE 1 ENVIRONMENTAL TEST REQUIREMENTS FOR SEMICONDUCTOR DEVICES AND INTEGRATED CIRCUITS

(Clause 6.1)

Sl. No.	TEST	REFERENCE TO CL No. OF IS : 589-1961*	ADDITIONAL DETAILS	REQUIREMENTS/REMARKS															
(1)	(2)	(3)	(4)	(5)															
A. MECHANICAL																			
1. Robustness of termination	a) Tensile	7.19.1	<p>The following forces shall be applied to each termination:</p> <table><thead><tr><th>Cross-sectional area of terminal, mm²</th><th>Approximate corresponding diameter of round wires, mm</th><th>Force†</th></tr></thead><tbody><tr><td>≤ 0.2</td><td>≤ 0.5</td><td>5 N (0.5 kg)</td></tr><tr><td>> 0.2 ≤ 0.5</td><td>> 0.5 ≤ 0.8</td><td>10 N (1.0 kg)</td></tr><tr><td>> 0.5 ≤ 1.2</td><td>> 0.8 ≤ 1.25</td><td>20 N (2.0 kg)</td></tr><tr><td>> 1.2</td><td>> 1.25</td><td>40 N (4.0 kg)</td></tr></tbody></table>	Cross-sectional area of terminal, mm ²	Approximate corresponding diameter of round wires, mm	Force†	≤ 0.2	≤ 0.5	5 N (0.5 kg)	> 0.2 ≤ 0.5	> 0.5 ≤ 0.8	10 N (1.0 kg)	> 0.5 ≤ 1.2	> 0.8 ≤ 1.25	20 N (2.0 kg)	> 1.2	> 1.25	40 N (4.0 kg)	When examined using 10 × magnification after removal of the force, there shall be no breakage (other than meniscus), loosening or relative motion between the termination and the device
	Cross-sectional area of terminal, mm ²	Approximate corresponding diameter of round wires, mm	Force†																
≤ 0.2	≤ 0.5	5 N (0.5 kg)																	
> 0.2 ≤ 0.5	> 0.5 ≤ 0.8	10 N (1.0 kg)																	
> 0.5 ≤ 1.2	> 0.8 ≤ 1.25	20 N (2.0 kg)																	
> 1.2	> 1.25	40 N (4.0 kg)																	
	b) Bending	7.19.2	<p>Two terminations on each device, in the case of devices with multiple terminations shall be selected in a cyclic manner when applicable (that is, terminations 1 and 2 of the first device, 2 and 3 of the second device and so on)</p> <p>Two consecutive bends on each termination shall be applied</p>	When examined using 10 × magnification after removal of the force, there shall be no breakage (other than meniscus), loosening or relative motion between the termination and the device															

*Basic climatic and mechanical durability tests for electronic components (revised).

†The values given in the brackets are only approximate values.

(Continued)

TABLE 1 ENVIRONMENTAL TEST REQUIREMENTS FOR SEMICONDUCTOR DEVICES AND INTEGRATED CIRCUITS — Contd

SL No.	TEST	REFERENCE TO CL No. OF IS : 589-1961*	ADDITIONAL DETAILS	REQUIREMENTS/REMARKS
(1)	(2)	(3)	(4)	(5)
	c) Torsion on lead termination	7.19.3	In the case of ultra-high-frequency and microwave diodes the torque applied shall be limited to 0.125 Nm	When examined using 10 × magnification after removal of the force, there shall be no breakage (other than meniscus), loosening or relative motion between the termination and the device
	d) Torsion on stud	7.19.4	The applied torque shall be specified in the relevant individual specification	The device shall be considered to have failed in this test if: <ul style="list-style-type: none"> a) the stud breaks; b) the stud exhibits elongation greater than one half of thread pitch; c) the device exhibits obvious visual mechanical deformations, such as: <ul style="list-style-type: none"> 1) stripping of threads, 2) deformation of mounting seat, 3) bending of stud; and d) the stud fails in any specified final measurements
2. Soldering	a) Solderability	7.18.2	Temperature of the bath shall be $230 \pm 5^\circ \text{C}$ and the period of immersion in solder bath shall be 2.0 ± 0.5 seconds	

b) Resistance to heat	7.18.2	Temperature of the bath shall be $260 \pm 5^\circ \text{C}$ and the period of immersion shall be 10.0 ± 1.0 seconds. The recovery time after this test shall be 1 to 2 hours	—															
3. Sealing	7.16	—	—															
4. Constant acceleration	7.7	a) For semiconductor devices and integrated circuit the severity for constant acceleration test shall be chosen from the following values:	—															
		<table><tr><td></td><td colspan="2">Acceleration</td></tr><tr><td></td><td><i>g</i></td><td>$\text{m/s}^2 \pm 10\%$</td></tr><tr><td>i) Parts weighing less than 15 grams [other than those covered by (ii) below]</td><td>20 000</td><td>1 96 000</td></tr><tr><td>ii) Parts where the semiconductor wafer is not mounted directly on to the header</td><td>10 000</td><td>98 000</td></tr><tr><td>iii) Parts weighing 15 g or above</td><td>5 000</td><td>49 000</td></tr></table>		Acceleration			<i>g</i>	$\text{m/s}^2 \pm 10\%$	i) Parts weighing less than 15 grams [other than those covered by (ii) below]	20 000	1 96 000	ii) Parts where the semiconductor wafer is not mounted directly on to the header	10 000	98 000	iii) Parts weighing 15 g or above	5 000	49 000	
	Acceleration																	
	<i>g</i>	$\text{m/s}^2 \pm 10\%$																
i) Parts weighing less than 15 grams [other than those covered by (ii) below]	20 000	1 96 000																
ii) Parts where the semiconductor wafer is not mounted directly on to the header	10 000	98 000																
iii) Parts weighing 15 g or above	5 000	49 000																
—	—	b) The acceleration shall be increased to the specified value gradually, in not less than 20 seconds and applied for a period of 60 seconds in each of the orientation X_1 , X_2 , Y_1 , Y_2 , Z_1 , Z_2 , (see clause 5) and decreased gradually to zero value in not less than 20 seconds	—															

*Basic climatic and mechanical durability tests for electronic components (revised).

(Continued)

TABLE 1 ENVIRONMENTAL TEST REQUIREMENTS FOR SEMICONDUCTOR DEVICES AND INTEGRATED CIRCUITS — *Contd*

SL No.	TEST	REFERENCE TO CL. NO. OF IS: 589-1961*	ADDITIONAL DETAILS	REQUIREMENTS/ REMARKS						
(1)	(2)	(3)	(4)	(5)						
5. Shock		7.5.2	a) The shock shall be applied in the orientations T_1 and T_2 and either X_1 or in Z_1 as applicable b) The acceleration and duration of shock pulse severities shall be chosen from the following: <table><tr><td><i>Peak acceleration A</i></td><td><i>Duration of pulse ms</i></td></tr><tr><td>100 g (981 m/s²)</td><td>6</td></tr><tr><td>1 500 g (14 700 m/s²)</td><td>0.5</td></tr></table>	<i>Peak acceleration A</i>	<i>Duration of pulse ms</i>	100 g (981 m/s ²)	6	1 500 g (14 700 m/s ²)	0.5	—
<i>Peak acceleration A</i>	<i>Duration of pulse ms</i>									
100 g (981 m/s ²)	6									
1 500 g (14 700 m/s ²)	0.5									
6. Shock simulated drop		—	This test is intended to determine the suitability of the devices to withstand severe shocks by providing for application of such shock directly to the devices The device shall be rigidly mounted or restrained by its case with suitable protection for the leads. The device shall then be subjected to the specified number of blows, each with an acceleration of 3 000 g peak and a pulse duration of approximately 0.2 millisecond, in each of the specified directions The following details shall be specified in the individual specification: a) Number and direction of blows b) Measurements during drop c) End-point measurements	—						

The object of this test is to detect the malfunctions of semiconductor device during vibration in the specified frequency range at specified acceleration

The device shall be rigidly fastened on the vibration platform. Special care is required to ensure positive electrical connection to the device leads to prevent intermittent contact during vibration. Care shall also be exercised to avoid magnetic field in the area of the device being vibrated. The device shall be vibrated with simple harmonic motion. The vibration shall be varied logarithmically between the specified frequency limits. Appropriate severities and duration in hours shall be chosen from the values specified below:

Frequency Range (Hz)	† Duration in Hours for Amplitudes of		
	0.35 mm (5 g)	0.75 mm (10 g)	1.5 mm (20 g)
10 to 55	1.5	6	—
10 to 500	6	6	—
10 to 2 000	—	6	6

With the specified dc voltages and currents applied, the device shall be monitored continuously, during the vibration period, for intermittent opens and shorts. The monitoring equipment shall be capable of detecting voltage or current changes of the duration and magnitude specified in the individual specification. In addition, the equipment shall utilise a positive indication 'GO — NO — GO'

*Basic climatic and mechanical durability tests for electronic components (*revised*).

†Displacement amplitude with acceleration amplitude given in parenthesis.

(Continued)

TABLE 1 ENVIRONMENTAL TEST REQUIREMENTS FOR SEMICONDUCTOR DEVICES AND INTEGRATED CIRCUITS — Contd

SL No.	TEST	REFERENCE TO CL No. OF IS : 589-1961*	ADDITIONAL DETAILS	REQUIREMENTS/REMARKS
(1)	(2)	(3)	(4)	(5)
			Technique or a recorded trace. Equipment requiring continuous visual monitoring, such as an oscilloscope shall not be used	
			The following details shall be specified in the individual specification:	
			a) Electrical test conditions	
			b) The duration and magnitude of the frequency range	
			c) Period of frequency transverse	
			d) Measurements during the test	
			e) End-point measurements	
			B. CLIMATIC TESTS	
	1. Climatic sequence			
	a) Initial measurements	—	Initial measurements as specified in the individual specification shall be carried out	—
	b) Dry heat	7.2	Appropriate severity, to be specified in the relevant specification shall be chosen from 6.1 of IS : 3700 (Part I)-1972†	—
	c) Damp heat accelerated first cycle	7.4	First cycle of damp heat accelerated test shall be carried out	—

	d) Cold	7.1	—	—
	c) Low air pressure	7.12	During this test and for a period of 20 minutes before, the test temperature shall be $25 \pm 3^{\circ}\text{C}$ The following additional severities are also applicable: 10 mbar (31 000 m) 1.5 mbar (46 000 m) The device shall have the specified voltage applied across its terminal and shall be monitored over the range from atmospheric pressure to the specified minimum pressure and return for any device malfunctions If the number of cycles is more than one, it shall be specified in the relevant individual specification	A device which exhibits arc-overs, harmful coronas, or any other defect or deterioration which may interfere with the operation of the device shall be considered a failure
	f) Damp heat, accelerated remaining cycles	7.4	The devices shall be subjected to the remaining number of cycles of damp heat, accelerated	—
	g) Final measurements	—	Final measurements as specified in the relevant specification shall be carried out	—
2.	Damp heat, long term	7.3	—	—
3.	Salt mist	7.10	The devices shall be permitted to dry for approximately 24 hours at $40 \pm 5^{\circ}\text{C}$ at the conclusion of the test, prior to examination	A device with illegible markings, evidence (when examined with no magnification) of flaking or pitting of the finish or corrosion that will interfere with the application of the device shall be considered a failure

*Basic climatic and mechanical durability tests for electronic components (*revised*).

†Essential ratings and characteristics of semiconductor devices: Part I General.

(Continued)

TABLE 1 ENVIRONMENTAL TEST REQUIREMENTS FOR SEMICONDUCTOR DEVICES AND INTEGRATED CIRCUITS — Contd

Sl. No.	TEST	REFERENCE TO CL No. OF IS: 589-1961*	ADDITIONAL DETAILS	REQUIREMENTS/REMARKS
(1)	(2)	(3)	(4)	(5)
4.	Rapid change of temperature	7.14	<i>Two-Chamber Method</i> — The conditioning time at each temperature extremes shall be either 30 minutes or one hour <i>Liquid-Bath Method</i> — Water shall be used as liquid. The number of cycles shall be 5 and the conditioning at each temperature shall be equal to or greater than either 15 seconds or 5 minutes	—
5.	Storage at high temperature	7.2	The temperature shall be chosen from the following for silicon and germanium devices: a) For silicon devices: $200 \pm 5^{\circ}\text{C}$, $175 \pm 5^{\circ}\text{C}$, $150 \pm 5^{\circ}\text{C}$, $125 \pm 5^{\circ}\text{C}$, $100 \pm 3^{\circ}\text{C}$ b) For germanium devices: $100 \pm 3^{\circ}\text{C}$, $85 \pm 3^{\circ}\text{C}$, $70 \pm 3^{\circ}\text{C}$ After temperature equilibrium has been reached, the device shall be exposed to the temperature condition for a period of 1 000 hours, unless otherwise specified in the relevant specification. The upper limit for recovery shall be 6 hours	—
6.	Storage at low temperature	7.1	The low temperature for storage shall be -55°C unless otherwise specified in the relevant specification. The period of exposure shall be specified in the relevant individual specification	

*Basic climatic and mechanical durability tests for electronic components (revised).

INDIAN STANDARDS

ON

SEMICONDUCTOR DEVICES

IS:

- 1885 (Part VII/Sec 1)-1970 Electrotechnical vocabulary: Part VII
Semiconductor devices, Section 1 General
- 1885 (Part VII/Sec 2)-1970 Electrotechnical vocabulary: Part VII
Semiconductor devices, Section 2 Diodes
- 1885 (Part VII/Sec 3)-1970 Electrotechnical vocabulary: Part VII
Semiconductor devices, Section 3 Transistors
- 1885 (Part VII/Sec 4)-1969 Electrotechnical vocabulary: Part VII
Semiconductor devices, Section 4 Thyristors
- 1885 (Part VII/Sec 5)-1971 Electrotechnical vocabulary: Part VII
Semiconductor devices, Section 5 Integrated circuits and
microelectronics
- 2032 (Part VIII)-1965 Graphical symbols used in electrotechnology:
Part VIII Semiconductor devices
- 2612-1965 Recommendation for type approval and sampling procedures
for electronic equipment
- 3700 (Part I)-1972 Essential ratings and characteristics of semiconductor
devices: Part I General
- 3700 (Part II)-1972 Essential ratings and characteristics of semiconductor
devices: Part II Low power signal diodes
- 3700 (Part III)-1967 Essential ratings and characteristics of semiconduc-
tor devices: Part III Rectifier diodes
- 3700 (Part IV)-1968 Essential ratings and characteristics of semiconduc-
tor devices: Part IV Low power small signal transistors
- 3700 (Part V)-1968 Essential ratings and characteristics of semiconductor
devices: Part V Power transistors
- 3700 (Part VI)-1968 Essential ratings and characteristics of semiconduc-
tor devices: Part VI Switching transistors
- 3700 (Part VII)-1970 Essential ratings and characteristics of semiconduc-
tor devices: Part VII Reverse blocking triode thyristors
- 3700 (Part VIII)-1970 Essential ratings and characteristics of semicon-
ductor devices: Part VIII Voltage regulator and voltage
reference diodes
- 3715 (Part I)-1971 Letter symbols for semiconductor devices: Part I
General aspects
- 3715 (Part II)-1971 Letter symbols for semiconductor devices: Part II
Diodes
- 3715 (Part III)-1971 Letter symbols for semiconductor devices: Part III
Transistors

3715 (Part IV)-1971 Letter symbols for semiconductor devices: Part IV
Thyristors

4400 (Part I)-1967 Methods of measurements on semiconductor devices:
Part I General

4400 (Part II)-1967 Methods of measurements on semiconductor devices:
Part II Low power signal diodes

4400 (Part III)-1968 Methods of measurements on semiconductor devices:
Part III Rectifier diodes

4400 (Part IV)-1971 Methods of measurements on semiconductor devices:
Part IV Reverse blocking triode thyristors

4400 (Part VIII)-1970 Methods of measurements on semiconductor
devices: Part VIII Voltage regulator and voltage reference
diodes

4411-1967 Code of designation of semiconductor devices

5000- Dimensions of semiconductor devices

NOTE — Standards on dimensions of semiconductor devices are published in loose
leaf form (priced) and are supplied in an attractive binder (priced). So far
26 standards have been published.

5001-1969 Guide for preparations of drawings of semiconductor devices

5469-1969 Code of practice for the use of semiconductor junction
devices

6553-1971 Environmental requirements for semiconductor devices and
integrated circuits

PUBLICATIONS OF INDIAN STANDARDS INSTITUTION

INDIAN STANDARDS

Over 7 000 Indian Standards covering various subjects have been issued so far. Of these, the standards belonging to the Electrotechnical Group fall under the following categories:

Acoustics and acoustical measurement	Instrument transformers
Automobile electrical equipment	Insulating materials
Batteries	Insulators and accessories
Cinematographic equipment	Integrating meters
Conductors and cables	Lamps and lamp accessories
Domestic electrical appliances	Lifts and escalators
Electric welding equipment	Lightning arresters
Electrical installations, codes of practice	Motors and generators
Electrical instruments	Nomenclature and symbols
Electron tubes and valves	Power capacitors
Electronic components	Power converters
Electronic equipment	Relays
Environmental testing procedures	Rotating machinery
Fans	Semiconductor devices
Flameproof electrical equipment	Switchgear and controlgear
High voltage techniques	Transformers and reactors
Illuminating engineering	Winding wires
	Wiring accessories
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